

## EVALUATING THE ECONOMIC IMPACT OF FIRE REGULATIONS IN BUILDING CODES<sup>1</sup>

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### ABSTRACT

A method is given for analysis of costs versus safety benefits of proposed building code revisions using monetary costs and numbers of lives that can reasonably be expected to be saved. The analytical procedure was applied to existing data in an example concerning the impact of reduced interior finish ratings on mobile home fires. With further development, this approach could afford building officials with a method to evaluate and compare proposed code revisions.

**Keywords:** Costs, benefits, building code revisions, mobile homes, fire safety, economic analysis.

### INTRODUCTION

For many years, there have been differing opinions on the economic impact of building codes and other regulatory requirements on the cost of construction. Some critics have charged that building codes promote inefficiency by limiting the builder's choice of design and construction materials. Others have stated that the economic considerations of building codes are relatively unimportant as long as maximum life safety for building occupants is provided. The U.S. Congress was certainly cognizant of the importance of economics when it directed the Department of Housing and Urban Development (HUD) to consider, among other things, "the effect of the standard on the cost of mobile homes to the public" when writing the Federal Mobile Home Standard.

As construction costs continue to rise at accelerating rates, it may be time for building officials and others involved in the construction process to give more thought to the economic consequences of some regulations. Paraphrasing a basic economic

principle, the closer we come to regulating the ultimate in life safety, the more expensive compliance will become. We must determine the level of safety for which one can reasonably expect people to pay.

Although it is impossible to set values for human life and suffering, it is important to develop a method by which code officials and regulatory agencies can measure the economic impact of these regulations and thereby compare one system with another. The development of such a technique for analyzing cost burdens versus safety benefits of proposed changes in building codes would undoubtedly help building officials and others responsible for evaluating and selecting regulatory alternatives.

The National Bureau of Standards (NBS) is working to develop procedures or models for evaluating the economic impact of building code changes. This work is being conducted by Dr. John McConnaughey in the Building Economics Section of the Center for Building Technology and is the basis for some of the comments on the subject.

The research presented here is the first phase of a larger project analyzing the economic impacts of building codes and only includes cost/benefit impacts associated with specific code provisions. A re-

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maintaining phase will consider income transfers between one group or industry and another.

#### BENEFITS AND COSTS OF BUILDING CODE REVISIONS

To evaluate the benefits and costs of a proposed code change, it is first necessary to pinpoint what benefits and costs are anticipated. Obvious benefits for the code official to consider are reduced fatalities, injuries, and property damage. Another would be reduction of building costs through liberalized design criteria that make allowances for specific technological advantages of various building materials. Still other benefits include improved energy conservation and sound control.

Costs of a proposed code change that should be evaluated include initial as well as recurring annual costs. Initial costs would include materials, direct labor, overhead, and other costs incurred during installation of the product or system. Recurring costs include any future maintenance and repair plus anticipated operating costs.

Many problems arise in any effort to objectively analyze the benefits and costs of a building code revision. One factor to consider in this type of analysis is that building code complexities discourage consistent interpretation, while another is the accuracy and completeness of available data. If the results of any analysis are to be valuable, the most accurate data available must be used. The Fire Data Center of the National Fire Prevention and Control Administration of the U.S. Department of Commerce is one agency collecting data on building fires. They have just initiated this program, and some of their statistics are still incomplete. However, even though some data are not available, it is often possible to make reasonable assumptions to evaluate code change proposals.

Some economists evaluate the statistical dollar value of human lives by analyzing potential loss of productivity to society. Others evaluate the amount of compensation paid to beneficiaries through life insurance, trusts, real estate, and other finan-

cial bequests. Who can say which method, if any, is appropriate?

With Dr. McConnaughey's approach, no specific value is computed for a human life. By examining the potential number of lives saved and estimating the cost of implementing the proposed code change, the evaluator determines the cost to society of saving a life. The code official can then evaluate the reasonableness of cost increases in the light of the increase in life safety expected from the change. Unfortunately, much of the present controversy over specific code provisions or proposed changes centers around the definition of "reasonable." A minimum criterion for reasonableness should require that the potential benefits from a specific provision equal or exceed the costs. Referring to an earlier comment, economic theory suggests that an optimum code provision is one whose net benefits can be maximized and where marginal benefits equal marginal costs.

A hypothetical example seems the easiest approach to explaining the procedures and methods the NBS has developed. First, it is necessary to determine the effectiveness of the proposed provision in preventing a hazardous event or reducing loss should it occur. For instance, assume a code change is proposed which would prevent death associated with a particular hazard that causes an estimated 6,500 deaths annually. If 2 million residences were protected in the year following the code change, out of a total of 80 million residences in the country, then 2.5% of the housing stock would be protected against that hazard during the first year. If the deaths are evenly distributed over the housing stock, then 2.5% of 6,500 or 163 lives could be saved that year. If the provision in question is judged only 40% effective, then only 65 lives would theoretically be saved. If the life-cycle of the instituted material requirement change is considered to be 20 years, then the provision might save 1,300 lives or 65 per year times 20. This number represents the benefits portion of the equation.

Next, costs of the provision are calculated. In the same example, assume that

initial costs for complying with the provision, including materials, labor, and other expenses, are determined to be \$100 per unit. With 2 million units required to comply with this provision, total initial cost to the nation would be \$200 million that year. A recurring annual cost of \$10 per unit or \$20 million nationally, discounted at 10% for 20 years, adds another \$170 million. The total cost of compliance with this provision would then be estimated at \$370 million and represents the cost portion of the equation.

The life-cycle cost per life saved would be \$370 million divided by 1,300 lives or \$285,000. After this result is reached and after making similar studies for other proposed code changes or provisions, the building official can judge whether or not the provision is reasonable. The official can also use this process to compare alternative solutions to this particular hazard. When information on lives saved or costs are uncertain, different assumptions can be introduced into the study.

#### A CASE STUDY: REDUCING MOBILE HOME FIRES

Now consider the use of this analytical process in a real-life situation. While preparing this article, Department of Commerce industry analysts were asked to evaluate the potential impact of reducing the flame spread requirement for interior finish in mobile homes from 200 to 75. Although some data were not available, a few assumptions were made that appear reasonable at least for illustrative purposes.

The National Fire Data Center of the National Fire Prevention and Control Administration has issued a *Preliminary Report Analyzing the Mobile Home Fire Situation in the United States* (Final report in press). In this report, they determined from a survey that in 1974 there were 16,000 mobile home fires with an estimated 250 associated deaths. Another source of mobile home fire data, the National Fire Protection Association (NFPA), has estimated 29,000 mobile home fires that year. However, travel trailers and motor homes

are included in the NFPA figure, so their figures cannot support those of the Fire Data Center.

Although an estimated 250 mobile home fire deaths per year are given, it is necessary to estimate the life savings per year if a reduced interior finish rating were required for all new mobile homes. One complicating factor in establishing this figure was the adoption a few years ago of the smoke detection requirement in mobile homes. NFPCA data indicate that three-fourths of all fire deaths in mobile homes occur between 10 p.m. and 6 a.m. However, it is not known whether the burned units did or did not have smoke detectors. Significant life savings could occur if early warnings through smoke detection were required in all old as well as new mobile homes.

The NFPCA survey also determined that 40% of all mobile home fires in 1974 were ignited in upholstery, bedding, and apparel by smoking materials. Since interior finish may not have been involved in these fires, improved flame-spread performance of walls and ceilings may not reduce fire deaths on a proportional basis. Therefore, several assumptions have to be made.

First, assume that gypsum wallboard is the most economical alternative to plywood for wall finish and that class II ceiling tile would be the logical material for ceilings. Since data were not available that would demonstrate the cost difference in building mobile homes with plywood versus gypsum walls, a figure was arrived at by assuming that design of the mobile home undercarriage would have to be altered to support the added weight of the heavier gypsum wallboard. Therefore, even though the initial costs to install the gypsum material might be equal to the costs for plywood, the increase in costs of undercarriage construction should be considered.

Gypsum wallboard  $\frac{5}{16}$  inch thick weighs about 1,100 lbs per thousand sq ft (MSF) compared to about 400 lbs per MSF for the plywood it would replace. Assuming a 14- $\times$ -70-foot average size for mobile homes with about 1,600 sq ft of wall area, the use of gypsum will increase the average mobile

home weight about 1,100 lbs. This will require about \$50 additional structural steel for each unit.

Recurring costs for repairs and refinishing the gypsum were not available. However, costs are estimated to be \$10 annually over the 10-year estimated life cycle of each unit.

Using these assumptions and the known data available, the above formula can be considered to estimate the cost of obtaining anticipated benefits of the proposed change. There are currently about 4 million mobile homes in use, and annual production of 300,000 units for the next few years is estimated. Consequently, in one year, 7.5% of the units would be affected by a change in interior finish requirements. Based on known information on when fire fatalities occur in mobile homes and the known benefits accruing from installation of smoke detectors, we assume the improved interior finish requirements will be 25% effective in saving lives:

$$\begin{aligned} & (250 \text{ deaths}) \times (0.075 \text{ units}) \times (0.25 \\ & \text{effectiveness}) \times (10\text{-years life cycle}) \\ & = 46.9 \text{ potential lives saved in 10 years.} \end{aligned}$$

The cost per potential life saved may then be calculated:

$$\begin{aligned} & (300,000 \text{ units}) \times (\$50 \text{ initial cost}) \\ & \quad = \$15,000,000 \\ & (300,000 \text{ units}) \times (\$10 \text{ recurring costs}) \\ & \quad \times (10\% \text{ discounted for 10 years}) \\ & \quad = \$18,400,000 \\ & \text{Total cost} = \$15,000,000 + \$18,400,000 \\ & \quad = \$33,400,000 \\ & \$33,400,000 / 46.9 \text{ lives} = \$710,000/\text{life} \end{aligned}$$

Is this a realistic evaluation of the proposed change? With more time to obtain better estimates on the cost for additional

framing and maintenance of mobile homes under the proposed provision, the estimates could be made more accurate. However, at least this calculation serves to illustrate the process in a real life example.

#### CONCLUSION

The work being conducted to aid evaluation of code changes has really just begun. The cost of code changes to both producers and consumers should be considered when measuring the value of increased safety. At some point, the cost of a safety measure goes beyond the actual benefits produced. To determine when that point has been reached, more extensive research is needed. When that research produces operative assessment procedures, all involved should benefit: the construction industry; the building materials industries; and most important, the consumer, who must ultimately bear the cost of code changes.

Improved analytic procedures would help assure that mandated improvements will provide benefits commensurate with their costs. The method discussed in this paper has great potential as a tool for building officials to use in evaluating costs and benefits of many proposed code changes. After the process has been perfected and fire data become more accurate and easier to obtain, the model code organizations may want to consider requiring that an economic analysis such as discussed here be presented by each proponent of proposed code changes having a significant impact on the cost of construction. However, many analyses must be performed so that realistic comparisons can be made, and the model code organizations would have to establish criteria on which assumptions and analyses could be based.